

# *Nuclear Theory Codes*

*B. Pritychenko*

*National Nuclear Data Center, Brookhaven  
National Laboratory, Upton, NY 11973-5000, USA*

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# Project Motivation

- This project was initiated by the INT Program on *“Interfaces between structure and reactions for rare isotopes and nuclear astrophysics,”* August 8 - September 2, 2011.
- Collaborative work with Alex Brown (MSU), Carlos Bertulani (Texas U. of Comm.), Vitali Denisov (KINR, Ukraine).
- NNDC is Worldwide code repository:  
<http://www.nndc.bnl.gov/codes>



# Reaction

- Reaction codes page was created by Alex Brown (MSU)
- It includes many codes such as Fresco, XFRESKO, TWOFNR, EMPIRE, ECIS, CHUCK, DWUCK, CCFULL
- <http://www.nndc.bnl.gov/codes>

The screenshot displays the National Nuclear Data Center (NNDC) website. At the top, there are navigation tabs for 'Main', 'Structure & Decay', 'Reactions', 'Bibliography', 'Networks & Links', 'Publications', and 'Meetings'. The 'Reactions' tab is active, showing a grid of links for 'Databases', 'Codes', 'Evaluations', and 'Tools'. Below this, there is a search bar and a section titled 'Nuclear Theory Codes' which includes a table of codes and their purposes.

Code	Purpose	Downloads	Documentation
Fresco	Coupled-reaction channels	source	manual getting started input examples
XFRESKO	Graphical interface for Fresco	source	
F2in	Creates two-nucleon transfer input for Fresco	source	manual input example



# Structure & Decay

- Alex is developing nuclear structure page content
- **UMADAC** ( $\alpha$ -decay &  $\alpha$ -capture) code from Vitali Denisov allows to calculate  $T_{1/2}$  for  $40 \leq Z \leq 130$  and can be very helpful in actinide evaluation process
- [www.nndc.bnl.gov/codes/UMADAC](http://www.nndc.bnl.gov/codes/UMADAC)

The screenshots illustrate the UMADAC web interface. The top screenshot shows the 'Nuclear Theory Codes' page with a search bar and navigation tabs. The middle screenshot shows the 'United Model for Alpha-Decay and Alpha-Capture (UMADAC)' input form with fields for Nucleus, Q-value, Transition, Angular Momentum, and deformation parameters. The bottom screenshot shows the 'Output Data' table with calculated values for parent nucleus, half-life, and transition energy.

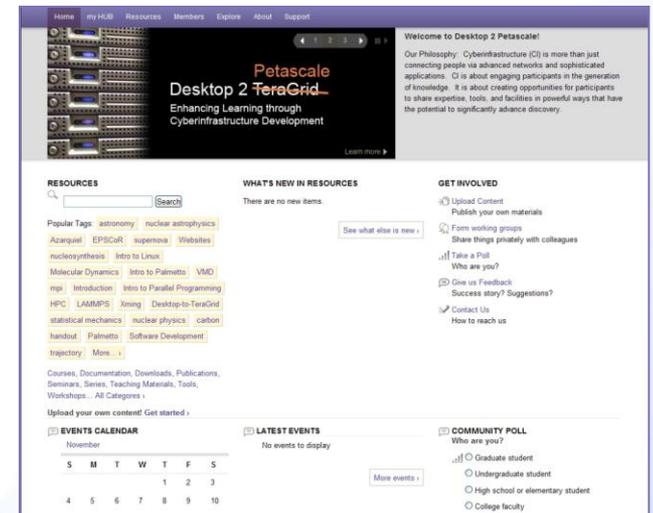
Input Data	
Nucleus (Parent Nucleus)	$^{238}\text{U}$
Q-value, MeV (Energy of alpha-decay transition)	4.27
Transition (Energy of alpha-decay transition is evaluated with or without subtraction of contribution of atomic electrons binding energy)	0
Angular Momentum (Angular momentum of transition carry out by alpha-particle)	0
$\beta_2$ (Quadrupole deformation parameter)	0.241
$\beta_4$ (Hexadecapole deformation parameter)	0.11

Output Data	
Parent Nucleus	$^{238}\text{U}$
Half-life in seconds evaluated in the UMADAC, $T_{1/2}$	$0.872378 \times 10^8$
$\log_{10}(T_{1/2})$	17.941
Half-life in seconds evaluated by using empirical relationship for full set of nuclei, $T_{1/2}^{\text{full}}$	$0.906790 \times 10^8$
$\log_{10}(T_{1/2}^{\text{full}})$	17.958
Half-life in seconds evaluated by using empirical relationship for light or heavy ( $Z \geq 82$ , $A \geq 124$ ) sets of	$0.401328 \times 10^8$

# Future Additions

- Collaboration with Brad Meyer (Clemson Univ.) on experimental hub:  
<http://desktop2petascale.org>
- Upload and deploy codes and files, **no problems with BNL or DOE cybersecurity**
- Brad will come to ND 2013 to discuss our cooperation



# Conclusion & Outlook

- NNDC users & nuclear physics community need a reliable place for code storage and downloads
- Nuclear structure codes will be available soon
- We can include more codes per user request
- Nuclear theory codes could be very helpful in the data evaluation process
- This project will help to increase NNDC user base and estimate real data needs
- Future work may involve collaboration with higher education

